(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 776 733 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.06.1997 Bulletin 1997/23

(51) Int. Cl.[6]: **B24D 3/28**, B24D 11/00, B24D 18/00

(21) Application number: **95402676.1**

(22) Date of filing: **28.11.1995**

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IE IT LI LU MC NL PT SE

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(54) Surface conditioning articles and methods of making same

(57) The present invention relates to a surface conditioning article comprising an organic matrix and water-based organic binders adhered to said matrix, said binders including a first binder and a second binder with abrasive particles dispersed and adhered within said second binder, wherein the first binder comprises a mixture of a phenolic resin and a carboxylated butadiene-acrylonitrile copolymer latex, in the range of weight ratio of dry materials of said latex versus said phenolic resin of 90/10 to 60/40.

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Printed by Rank Xerox (UK) Business Services
2.14.6/3.4

Description

The present invention relates to surface conditioning articles formed from an organic matrix coated and engulfed by organic binders. The present invention also relates to a method for making a layered composite from which a surface conditioning article may be machined.

Surface conditioning articles are surface treatment articles formed from an organic polymeric matrix formed of a solid or foamed organic polymer or a nonwoven fiber web find utility in treating a surface to prepare it for further coatings. Burrs and flashing from cast, drilled or punched parts must be removed to produce a desired shape or surface finish. Surface conditioning articles in the form of wheels, discs, or belts operating at high speeds and high pressures must have sufficient strength and durability when subjected to high use pressure against the workpiece. It is desirous for the article to be flexible to intrude into crevices in the workpiece. In addition, the propensity of the article to smear onto the workpiece must be taken into consideration. Smearing is generally considered deleterious.

As used herein the term "smear-resistant" is meant to denote embodiments of the invention exhibiting substantially no visible signs of the surface treatment article remaining on the workpiece after the workpiece article has been treated. The articles of the invention can be urged against a workpiece at high operating speeds and/or pressures without smearing of the article onto the workpiece. The term "surface conditioning" is used here to include all steps between preliminary removal of material and final polishing or finishing step. Those steps comprise, grinding, lapping, deburring and the like.

Polymeric resinous binders used to bond the matrix or to secure abrasive particles within the matrix of such products have generally been either of the hard thermosetting type or the strong, tough elastomeric type. Hard thermosetting resins, such as base catalyzed phenol formaldehyde, are widely used to secure abrasive particles to sheet-like backing or to the fibers of a nonwoven web. Such hard resin binders, while usually having high tensile strength, low elongation at break or failure, and resistance to significant change when subjected to elevated temperatures, are undesirably susceptible to brittle fracture. Strong, tough elastomeric resin binders are more desirable in certain applications which require tougher, more durable surface treatment products. Such elastomeric binders have excellent tensile strength, a very high elongation at break, and resistance to brittle fracture but may exhibit significant softening at elevated temperatures as might be encountered when the surface treatment article is urged against a workpiece at high speeds and pressures. Such softening may result in smearing or transfer of portions of the article to the surface of the workpiece, which as described previously is not desired by the user.

The surface conditioning industry is continually striving for articles which more closely meet user demands. In addition, methods of producing surface conditioning articles that are kind to the environment, particularly the air and water, are especially strived for.

In light of the above user-driven demands it would be advantageous if surface conditioning articles could be developed which, by virtue of simple adjustment of binder ingredients, can be tailored to be flexible, substantially non-smearing at use pressure and temperature, all while using water-base formulations in the manufacturing processes which do not require use and subsequent removal of volatile organic hydrocarbons.

Specific properties needed for the coatings are linked to the final product applications. Preferably, the articles of the invention are flexible and conformable to allow for their use on complex or textured surfaces and to permit the manufacture of endless belts, for example. The inventive articles should be resistant to both abrasion and brittle fracture to thereby avoid excessive wear of the articles during use. The articles should be heat resistant to withstand the high temperatures typically experienced when the articles are subjected to high use pressures and/or speeds while simultaneously avoiding smearing on the treated surfaces.

The standard reference product currently existing is made with urethane resins used in a solvent based system and catalyzed with an MDA (methylene dianiline). Several trials have been run to find a water based alternative for the use of such solvent based resins.

Surface conditioning articles have been made by the following generally known scheme. A first or "prebond" coating of a binder precursor solution, which includes one or more of the above-named resins, is coated on the web and cured by exposure to heat in order to impart sufficient strength to the nonwoven web for further processing. Then a "make" or "slurry" coating comprising a resinous organic binder is applied to the web to secure fine abrasive grains throughout the lofty fibrous mat and cured. Thereafter, a "size" coating of resinous binder material and optional abrasive particles is applied, usually by spray-coating, over the prebonded web to increase the abrasive characteristics of the article, such as preventing the abrasive mineral from shelling. Then, the size coating is cured. The resins of the various "prebond", "slurry", and "size" coatings may be chemically different.

The use of solvent-coated crosslinked urethanes in the "prebond" provides the requisite elasticity and protect nylon fibers of the web from attack by subsequently applied phenolic make coats used for bonding of abrasive particles onto the fibers of the web.

Additionally, the prebond coat protects the fibers of the web from softening when the article is used under high application pressures.

Phenolic resin binders, in particular, are used extensively to manufacture nonwoven abrasive articles as a binder

for the abrasive particles because of their thermal properties, availability, low cost, and ease of handling. The monomers used in greatest volume to produce phenolic resins are phenol and formaldehyde.

In order to reduce emissions of "VOCs" (volatile organic compounds), it has been suggested to increase the water compatibility of phenolic resins. J.D. Fisher, in an article entitled "Water Compatible Phenolic Resins" in *Proceedings of the American Chemical Society, Division of Polymeric Materials : Science and Engineering ;* n° 65, pp. 275-276 (1991), describes methods of making "water compatible" phenolic resins, their benefits, and their shortcomings.

Also, a compatibility problem arises from the use of the phenolic binder in particular together with a nonwoven web based on polyamide fibers. A particularly useful known nonwoven abrasive article is one comprising a web of polyamide fibers and a binder comprising resole-type phenolic resins. Such a composition provides for strong, tough, temperature resistant abrasive articles that may be made economically.

Rubber-modified phenolic resins have also been used in the manufacture of nonwoven abrasive articles, such as in the disclosure of commonly assigned U.S. Patent N° 2 958 593 (Hoover et al.), as an optional rubber treatment disposed on one side of the structure to increase the resistance of the overall abrasive article structure to tearing and shredding. For example, Hoover et al. exemplifies a nylon fiber web being first coated with a phenol-formaldehyde and amine terminated polyamide resin-containing coating, followed by transmitting the phenol exposed web to a curing oven where the coated web is so heat-treated such that the emitted treated web is cured to a nontacky state while still warm, and, only thereafter, a rubbery composition based on a butadiene acrylonitrile copolymer latex (viz. trade designation "Hycar® Latex 1561", from B.F. Goodrich Co.) is applied to the opposite side of the web and heat-cured in an oven.

The modification of a phenolic resin precursor system used for binding, lower tenacity polyamide web fibers by the presence of a low rate of butadiene acrylonitrile latex, less than 40 %,, as a modifier agent therewith which alleviates the degradation of polyamide fibers in the presence of phenol, has been disclosed in US patent application n° 08/297,807. In this application, the function of the latex is to improve the mechanical characteristics of a phenolic impregnated web and especially reduce the tearing of the open low-density nonwoven abrasive article.

The goal of the present invention is to provide surface conditioning articles which can be urged against a workpiece at high pressure and/or high speed with no undesirable smearing or other transfer of the article to the workpiece surface. The goal of the present invention is further to provide a surface conditioning article prepared with water-based formulations, said article having properties, especially, flexibility and smear resistance, equivalent to polyurethane standard reference article currently existing.

Water-based formulations for surface treating products having a wider range of possible use than the specific surface conditioning article of the present invention, have been disclosed in US 5 306 319. The water-based formulations of US 5 306 319 comprise binders consisting in a reaction product of polyurethane prepolymers and a plurality of adducts. These adducts render the preparation method difficult and costly. Moreover, the properties do not totally satisfy all of the customers needs defined as "cut", "wear resistance", "smear resistance" and "flexibility" for the specific field of the surface conditioning article.

Another goal of the present invention is therefore to provide new water-based formulations particularly useful as surface conditioning article, which are less expensive to manufacture than the articles disclosed in the aforemontioned US patent n° 5 306 319.

For doing this, a first aspect of the invention is a surface conditioning article comprising an organic matrix and water-based organic binders adhered to said matrix, said binders including a first or "prebond" binder and a second or "slurry" binder with abrasive particles dispersed and adhered within said second binder, wherein the first binder comprises a mixture of a phenolic resin and a carboxylated butadiene-acrylonitrile copolymer latex, wherein the weight ratio of dry materials of said latex versus said phenolic resin is in the range of 90/10 to 60/40.

Phenolic resin provides hardness, cohesion, adhesion of the fiber web and between different layers and high thermal resistance to the coating ; it is a perfect support for the layers which include minerals in abrasive applications. Phenolic resin may be too brittle and too hard to be used alone in an alternative coating to urethanes. The phenolic resin used preferably will have a very high water tolerance to allow admixture with a high percentage of a latex dispersion without the formation of gels denoting incompatibility. Such a phenolic resin would not have advanced much in the condensation reaction between formaldehyde and phenol and would have a low molecular weight.

In a preferred embodiment, the said phenolic resin of the first binder is a resole-type phenolic resin with a water tolerance of at least 500 % by weight. More particularly, the water tolerance comprises from 500 to 2500 %. A water tolerance of 500 % by weight means that the resin can be mixed with 5 times its own weight with water without precipitation.

Preferably the first binder has a molecular weight in the range of 100 to 1000.

An important function of the carboxylated butadiene-acrylonitrile latex (herein after referred to as "NBR" latex) in the present invention is to provide outstanding thermal resistance for a flexible coating. This protects the fibers from softening at high temperatures. This gives to the final product flexibility and smear resistance in the same time. This function is linked to the way carboxylated NBR latex degrades with temperature -cyclize before melting- in contrast to systems where such a cyclization is not possible. They show no residual thermoplasticity whatever ; a property that makes for example NBR latexes highly suitable components for brake lining and clutch plate facings.

NBR latex provides high flexibility (Tg close to -30°C), conformability, softness, and very high resistance to flex fatigue and very good mechanical properties for such flexible coatings. It shows high resistance to abrasion and wear. It keeps high flexibility at low temperatures. In view of all these properties, it is preferred to use a carboxylated NBR latex with high acrylonitrile ratio especially wherein the said butadiene-acrylonitrile latex has a molar percentage of acrylonitrile of at least 25 %. More particularly the molar percentage of acrylonitrile is from 25 to 35 %.

In a preferred embodiment, the latex particles have a size in the range of 10 to 500 nm.

The articles of the invention have a wide available range of flexibility and smear-resistance, thus making them useful in articles designed to abrade a workpiece, deburr a workpiece, wipe the surface of a workpiece, or buff a workpiece. In addition, the inventive binder is applied to the organic matrix in the form of an aqueous composition, thus eliminating or substantially reducing the release of volatile organic compounds in the process of making the inventive articles. The carboxyl groups allow self crosslinking of the copolymer without use of catalyzing agents.

In one embodiment, the organic matrix comprises an open, lofty, three-dimensional nonwoven web of the article which comprises a plurality of organic polymeric fibers bound together at mutual contact points by the first binder.

In a preferred embodiment of the present invention, the article comprises a third or "size" binder coated over the second binder, said third binder comprising a mixture of phenolic resin and carboxylated butadiene acrylonitrile copolymer latex.

More preferably, the weight ratio of dry materials of said latex versus said phenolic resin in the third binder is in the range of 60/40 to 40/60.

In one embodiment, the phenolic resin and carboxylated butadiene-acrylonitrile latex are the same in the first and third binders.

The phenolic resin of the first and third binders may be selected from commercial materials. Suitable commercial phenolic resins for use in the first and third binders include those available under the trade designation Lacfen 420® available from Satef Huttens Albertus Spa as well as SW378® available from Bakelite. Suitable commercial butadiene-acrylonitrile latex materials include those known under the trade designations Perbunan® N2890 from Bayer as well as LN240S® available from BASF.

The second binder of the article according to the present invention may comprise conventional water-based resole-type phenolic resin.

Another aspect of the invention is a method of making a layered composite from which a surface conditioning article according to the present invention may be machined, the metod comprising :

a) coating a major portion of the organic fibers of an open, lofty, three-dimensional nonwoven web with a first binder composition;
b) exposing the first coated web to energy sufficient to at least partially cure the first binder composition to form an open, lofty, three-dimensional nonwoven prebonded web of fibers ;
c) coating at least a portion of the fibers of the prebonded web with an aqueous slurry comprising water, abrasive particles and a said second binder to form a second coated web ;
d) exposing the second coated web to energy sufficient to cure the second binder ;
e) coating at least a portion of the fibers of the second coated web with a third binder ;
f) exposing the third coated web to energy sufficient to cure the third binder, remove substantially all the water, thereby forming a substantially dried web ;
g) juxtaposing a plurality of substantially dried webs of step f) to form a precursor layered composite ; and
h) compressing the precursor layered composite with pressure and at a temperature sufficient to form the layered composite.

In one embodiment before step a), the method comprises :

1) forming an open, lofty, three-dimensional nonwoven web of organic fibers ; and optionally
2) entangling the organic fibers of the nonwoven web to form an entangled web.

Preferred are those methods wherein the layered composite is machined into the form of a surface conditioning article, in the form of a disc, wheel, endless belt;, rectangular block, and the like.

The nonwoven web may be selected from commercial materials.

However, another aspect of the invention is a method of making an open, lofty nonwoven surface conditioning article, wherein the step a) comprises two sub-steps :

a) forming an open, lofty, three-dimensional nonwoven web of organic fibers ; and
b) entangling the organic fibers of the nonwoven web to form an entangled web.

Surface conditioning articles of this inventions are suitable for use in a variety of applications. They may be adapted

for use on any workpiece composition including metal, wood, plastics, composites, glass, ceramics, concrete, and others. They are designed for a use intermediate between the aggressive removal of material from a workpiece and clean a workpiece in preparation for painting, plating, etc...

Surface conditioning articles of the invention are especially effective in conditioning metals without substantial smearing onto the metal workpiece.

When the surface conditioning article of the invention is rotated against a workpiece under heat-generating conditions such as high wheel to workpiece pressure and surface speed, these conditions do not cause surface portions of the wheel to smear, or transfer onto the surface of the workpiece.

An important aspect of the invention is that articles of the invention employ inventive binders which allow the articles to exhibit a high flex fatigue resistance (in other words, able to deform and penetrate into grooves and indentations in a metal workpiece, and then return to its original shape, in a cyclic process).

The binders may contain optional additives or fillers such as colorants, thickening agent, pH buffering agent and scavengers._A s previously stated, binders are applied to the organic matrix in the form of aqueous compositions (emulsions, dispersions, or slurries). The aqueous compositions may comprise plasticizers, viscosity modifiers, grinding aids and abrasive particles.

Thickeners may be used to adjust the viscosity of the aqueous or solvent dispersed binder system, i.e., when in the liquid state, in order to provide for an easily-coatable composition. Examples of suitable thickeners include salt of polyacrylic acid carboxymethyl cellulose, guar gum, gum tragacanth, homo- and copolymers of poly(vinyl alcohol), methyl cellulose, modified starch, and the like. The thickening agent increases viscosity of the wet mix so that sufficient weight can be applied with a roll coat process on the fiber web.

Suitable pH buffering agents may include materials like triethanolamine, ammonia. pH buffering agent helps thickening efficiency without leaving residual basic component in the wet coating during drying.

Suitable scavengers may include materials like urea, or melamine. Scavengers minimize formaldehyde emissions of phenolic resins during drying.

Examples of colorants are inorganic pigments, organic dyes, and the like. Fillers may include, for example, short organic or inorganic fibers, spheres, or particles. Grinding aids may be materials such as poly(vinyl chloride), potassium fluoroborate, and the like. Fillers may include calcium carbonate, fumed silica, and other materials which are primarily inert with respect to the utility of the articles. Plasticizers may include, for example, phthalic acid esters, oils, and other relatively low molecular weight materials.

Abrasive particles are added to the binder system to render the inventive surface conditioning article more aggressive in its action on a workpiece. Suitable abrasive particles include those commonly used in the art. The abrasive granule size and type may be any of those commonly used to make surface conditioning articles. Examples of suitable abrasive particles include silicon carbide, aluminum oxide, cerium oxide, alumina zirconia, cubic boron nitride, garnet, pumice, sand, emery, mica, flint, talc, corundum, quartz, diamond, boron carbide, fused alumina, sintered alumina, alpha-alumina-based ceramic material (available from Minnesota Mining and Manufacturing Company, Saint-Paul, MN under the trade designation "CUBITRON"),and mixtures thereof. Agglomerate abrasive particles, such as those described in U.S. Patents n° 4 652 275 and 4 799 939 may also find utility. Softer abrasive particles such as those made of thermoplastics or thermosetting materials glass as well as other softer abrasive particles may be used for polishing applications. It is considered within the skill of the artisan to select the appropriate abrasive material for the particular use without undue experimentation.

The organic matrix serves the function of providing strength and structural integrity to the surface conditioning articles of the present invention while also providing a substrate for the binders and abrasive particles.

The organic matrix may be either a solid of foamed organic polymer or a nonwoven web comprised of organic fibers, preferably hydrophilic organic fibers. If hydrophilic organic fibers are employed, a heating step may be eliminated or reduced as the fibers will absorb water from the emulsified binder. An example of a lofty, nonwoven web formed of crimped staple fibers adhered at points of contact with binder which contains abrasive particles is taught in U.S. Patent N° 2 958 593 (Hoover et al.). U.S. Patent N° 4 227 350 (Fitzer) discloses a matrix formed of three-dimensionally undulated inter-engaged autogenously bonded continuous filaments.

The organic matrix may be comprised of thermoplastic organic staple fibers, such as nylon (polyamide), polyester, and the like or a combination of thermoplastic and cellulosic staple fibers, such as viscose rayon, and the like. Preferred thermoplastic fibers are nylon staple fibers, especially nylon 6,6. If a combination of thermoplastic organic fibers and cellulosic fibers are employed. The weight of cellulosic fibers as a percentage of the total fibers weight may range from about 5 weight percent to about 50 weight percent.

In a preferred embodiment, said open, lofty, three-dimensional nonwoven web comprises organic polyester or polyamide fibers.

The fibers preferably have denier ranging from about 10 to 100 and length ranging from about 10 to 100 mm.

The surface conditioning article within the present invention may be applied on a support such as a support made of cellulosic fibers, or the surface conditioning article may comprise the said organic matrix affixed to a reinforcing scrim such as a woven scrim of nylon, PET or other fabric in order to consolidate the organic matrix especially the non-woven

web.

Surface conditioning articles within the present invention may take any of a variety of conventional forms such as sheets, blocks, strips, belts, brushes, rotary flaps, discs, or solid or foamed wheels. Especially useful forms are wheels in the form of a disc or right circular cylinder having dimensions which may be very small, e.g., a cylinder height on the order of a few millimeters, or very large, e.g., two meters or more, and a diameter which may be very small, e.g., on the order of a few centimeters, or very large, e.g., one meter or more. The wheels typically have a central opening for support by an appropriate arbor or other mechanical holding means to enable the wheel to be rotated in use. Wheel dimensions, configurations, means of support, and means of rotation are well known in the art. A useful summary of various wheel forms of surface treatment articles which may be made using the inventive binders are described in the publication "3M Wheels", published in 1990 by Minnesota Mining and Manufacturing Company, Saint-Paul, MN ("3M"), which is incorporated herein by reference.

Surface treatment articles of the present invention comprising an organic matrix and a binder adhered to said matrix may be prepared by forming a layered composite. Layered composites (known in the art as "slabs") may be produced by cutting, punching, or otherwise machining uncured or partially cured webs into sheets or discs which are then overlapped on one another and then compressed and cured to make a higher density slab. Such cutting, punching and other machining techniques are well known to those skilled in the art.

A layered composite may be used as the source of a multitude of articles of the invention each having various diameters, or all the same diameter, as required by the user. Article of the invention may be produced form the layered composites by machining using appropriate techniques which are also well known in the art. For example, a wheel shape may be die cut from a slab of the layered composite. Additionally, ribbons, strips, or elongate segments of the layered composite may be spirally wound into a wheel shape while the binder is uncured or partially cured and then fully cured to yield a wheel.

Further aspects and advantages of the invention will become apparent from the drawing figures and description of preferred embodiments and examples which follow.

Figure 1 represents the results of the study of prebond flexibility versus latex/resin dry ratio for the products of the Examples.

Figure 2 represents the results of the study of wear resistance versus latex/resin dry ratio for the products of the Examples.

Figure 3 represents the results of the prebond study of the "cut" versus latex/resin dry ratio for the products of the Examples.

Figure 4 represents the results of roughness measurements versus latex/resin dry ratio of the size binder at the "size" level for the products of the Examples.

Figure 5 represents the results of the effect on disc "wear" versus the dry ratio latex/resin at the "size" level for the products of the Examples.

Figure 6 represents the effect on "cut" versus the dry ratio latex/resin at the "size" level for the products of the Examples.

Figure 7 represents the results of tables 1 and 2 for "smearing resistance", "edge resistance", "paint removal" and "loading resistance"for the articles of Examples 15-25.

Figure 8 represents the results for "cut & wear in belt disc form" and for "finish level on stainless steel" for the articles of Examples 15-19.

1.General features of the product preparation

The articles of the invention are preferably made in a four step process, as described below. In the following description of the general process conditions, reference is also made to the specific conditions employed in the Examples herein.

1.1. Fiber web forming : A non-woven web is formed from staple fibers comprising nylon, polyester or the like. The fibers of the web have a linear density within the range from 10 to several hundred denier and lengths within the range from about 10 to several hundred millimeters. The fibers may be crimped or noncrimped. A web comprising the foregoing fibers can be made by a combination of several known processes including air laid, carding, cross lapping and needle tacking. A woven scrim of nylon, PET or other fabric can be used to consolidate or reinforce the non-woven web. The scrim can be affixed to the web by needle tacking, for example. In the Examples, the fiber web comprises 60 and 100 denier nylon fibers (obtained from Wellman International Limited LTD.) of approximately 76 millimeters in length. The web was preformed on a carding machine (from Octir Spa Italia) and further consolidated on a cross lapping machine (from Asselin) to form a cross lapped web having eight layers and a weight between about 300 to 350 grams per square meter. The web was then needle tacked on a needle tacking machine (from Fehrer AG, Austria) to fix the cross lapped layers to one another. A second needle tacking step was performed to affix a nylon (or PET) woven fabric to the cross lapped web to increase the strength of the web for the manufacture

of endless belts. The weight of the woven fabric was 150 grams per square meter, and the web thickness was from 5 to 15 millimeters.

1.2. Prebond Roll coat : The fiber web is saturated with a coatable prebond resin composition applied in a known manner (e.g., by roll coating with a two roll coater) to saturate the fibers of the web. The weight of the wet prebond resin applied to fiber web is typically enough to saturate the web (i.e. from about 10 to several thousand grams per square meter). The wet prebond coating is then dried to a nontacky state in an oven at a temperature within the range from about 90 to 170°C for a minimum of about 10 minutes. In the Examples, the prebond coating was dried at 90 to 110°C for 15 minutes.

1.3. Slurry spray : The prebonded web is treated along one of its surfaces with a mixture of phenolic resin and abrasive particles to provide a make coat with high mechanical and thermal resistance. The make coat resin is applied in a known manner, typically applied by spray coating, over a major surface of the prebonded web, and the weight of the resin is dependent upon the contemplated application for the finished article. Typically, the weight of the make coating resin is within the range from 10 to several thousand grams per square meter. The make resin is subsequently dried in an oven at a temperature between about 100 and 170°C for a short period of time (typically less than 10 minutes). In the Examples, the make coat slurry was dried at 100 to 145°C for about 6 minutes.

1.4. Size spray : After the make coat is cured, a size coating composition is applied thereover, typically by spraying. The size coating is applied as a coatable resin composition which, when cured, forms an outer layer on the finished article capable of protecting the make coat from excessive initial wear during use. The wet weight of the size coating composition will depend on the contemplated end use of the article and typically will fall within the range from about 10 to several thousand grams per square meter. The size coating is then dried in an oven at a temperature between about 100 to 170°C for over an hour to completely cure the resin. In the Examples set forth below, the size coating was cured at a temperature between 100 and 145°C for a period of two hours.

1.5. Converting : The foregoing product can then be rolled up for storage or for further processing. In the manufacture of useful articles, the roll is unwound and converted in a known manner into any of a variety of finished products. Useful articles within the scope of this invention include disks, endless belts, hand pads, rolls, wheels, brushes and the like.

2. Test methods

2.1. Performance test in belt form : "cut" and "wear" : The foregoing product is converted into an endless belt by cutting a rectangular piece of material sufficient to provide a belt 2500 millimeters in length and 50 millimeters wide. The ends of the rectangular piece are joined using an adhesive splice. The belt is placed on a conventional back stand machine operated at 2830 rpm and having a rubber contact wheel with a hardness within the range of 80 to 90 shore A and a diameter of about 200 millimeters. The surface of the contact wheel includes serrated valleys at a 1:1 ratio with an angle of 45°.

Steel bars (XC38REF) are used in testing the grinding materials. The bars have a length of 200 millimeters and a diameter of 20 millimeters and are placed in a holder and positioned longitudinally with respect to the belts during testing. Grinding pressure is 5.8 kilograms for each 50 millimeters wide belt. The running cycle is 30 seconds and is repeated four times per bar for a total of 24 cycles. The removed steel on each bar is measured and report as "cut" and the weight loss of the belt is reported as "wear". Grinding efficiency is reported by the ratio of cut/wear.

2.2. Performance test in disc form : "cut" and "wear" : Product is converted to a disc form of 178 mm diameter with a centered hole and fixed on a holder (3M Brand Disc Pad holder European ref. 09921) for testing. A pneumatic portable machine (type Brand G. Renoult PL 120 with an operating speed of 2000 rpm) is used to perform the test. This pneumatic device is mounted on a robotics station (type brand ABB 3000 from Asea Boveri Brown St-Ouen l'Aumone, France) equipped with a compliance system which controls pressure). The portable tool with a disc mounted on it, is presented by the robotics station to a holder which supports 20 stainless steels sheets.

These sheets (30 x 80 x 1 mm) are positioned vertically within the holder spaced 5 millimeters apart from one another. The sheets are affixed within the holder lengthwise and the edge of the grinding disk is applied to the sheet and run from left to right for a period of 30 seconds. The disk applies a pressure of approximately 4 kilograms at a running speed of approximately 16 millimeters per second. The angle between the disk and the floor is about 7 degrees. The loss of the removed steel on each blade is measured and the total is reported as "cut". The weight loss of the disk is also measured at the end of the test and reported as "wear". "Efficiency" is also reported as the ratio of cut/wear.

The value of the number obtained for "cut" represents the ability of the abrasive product to remove material (e.g., rust or paint) during typical applications. The number obtained for "wear" of the abrasive product correlates with the useful life of the product. In general, a higher value for wear (expressed as a percentage) indicates a shorter useful life for the product.

2.3. Performance test : hand tool evaluation (in disc form) : Product is converted into disk form having a diameter of 178 mm without a center hole. The disk is fixed in a holder (3M brand Disk Pad Holder reference 0917) for test-

ing. A portable pneumatic machine (type brand G Renault PL 120 with an operating speed of 200 rpm) is used to perform the test. The durability of the disk is visually evaluated after having ground the edge of the disk on a carbon steel block over a period of approximately 20 seconds. The performance of the product is represented by the time required for removal of the paint coating from a standard painted panel used in automotive applications. Load resistance is visually evaluated after the removal of the paint coating. Smear resistance is visually evaluated by the application of increased hand pressure and visually evaluating whether the disk has left a smear coating on the stainless steel block.

2.4. Performance test : finish & smearing resistance evaluation : Product is converted to a disc form of 178 mm diameter without a center hole and fixed on a holder (3M Brand disc Pad holder ref. 0917) for testing. A pneumatic portable machine (type Brand G. Renault PL 120 with an operating speed of 2000 rpm) is used to perform the test. This pneumatic device is mounted on a robotics station (type Brand ABB 3000 equipped with a compliance system which controls pressure). The portable tool with a disc mounted on it, is presented by the robotics station to a stainless steel sheet of 50x50 cm with an initial finish quality reference 2B. The machine performs two runs on the metal from top to bottom with a rotating speed of 2000 rpm, length of the ground surface is approx. 30 cm in approx. 15 seconds, pressure is controlled to 4 kg and running angle is close to 7°.

Finish level is evaluated with roughness measurements using a Perthometer device (ref. PRK S8P from Mahr Perthen Cy -Göttlinger-D3400 Germany) ; the roughness values Ra, Rz and Rmax are registered.

Smearing resistance is visually evaluated by looking if the disc has left a "smearing coating" on the stainless sheet.

2.5. Flexibility evaluation method:

Each test article was evaluated to determine its relative flexibility. In this evaluation, the articles are manipulated by hand to determine their relative flexibility compared with the flexibility of the article of a control (e.g., Control Example A) which is assigned a flexibility value of 100. Articles which are more flexible than the control are assigned a value less than 100 while articles which are more rigid than the control will be assigned a value greater than 100. The range of acceptable flexibility is between 75 to 125 (±25) around the target value of the control.

3. Reference product : control example A

A commercial available surface conditioning belt was used in the examples as control example a. The surface conditioning belt is commercially available from the Minnesota Mining and Manufacturing Company of Saint-Paul, Minnesota under the trade designation SCOTCH-BRITE and is a scrim-backed surface conditioning belt comprising 80 grit aluminium oxide abrasive particles adhered to a nonwoven substrate by a cured phenolic resin. A flexible urethane resin size coat covers the phenolic. The nonwoven substrate comprises 70 and 58 denier fibers needle tacked on a nylon open scrim.

4. Example products

4.1. Raw material characteristics of the phenolic resin and NBR latex of prebond and size binders

4.1.1.

Product type	Phenolic resin
product name	LACFEN 420
Supplier name	Satef Huttenes Albertus Spa-Italy
Main characteristics	solids 60-62 % (3hrs at 135°C)
	Brookfield viscosity : 40/60 cps
	cure time : at 120°C : 15'+/-1
	pH : 8,5+/-1
	Free phenol : 0,9/1,0 %
	Free formaldehyde : 3,0/3,5 %
	Medium MW = 180 - 190

4.1.2.

Product type	NBR latex (butadiene-acrylinotrile copolymer with carboxylic groups self crosslinking colloidal dispersion)
product name	Perbunan N 2890
Supplier name	BAYER
Main characteristics	solids 41 +/-0,5 %
	Dispersion type : anionic/non anionic

Volumic weight : 1,02g/cm^3
pH : 7,5+/-1
Brookfield viscosity : approx 14 cps (SL 1S60)
Particules size : approx 100 nm
High nitrile ratio : 28 %

4.1.3. Other components

NAMES	SUPPLIERS
Carbosol CMC (Carboxymethyl cellular)	LAMBERTI SpA
Brown Pigment (Marrone Permasol - Mu)	SICOM SRL
80 Grit AL203	SMYRIS ABRASIVI SRL
100 Grit AL203	SMYRIS ABRASIVI SRL
Policril 307 R (polyacrylic resin)	FAR FABRICA ADESIVI RESINE SpA
Melamine powder	BASLINI SpA
Calcium carbonate	MAFFEI SpA
TEA (Triethanolamine 85)	IPCOCHEMICALS SpA
Nylon Scrim (Nylon 6363/8401 Scrim)	TESSITURA QUADRELLI SpA
60 denier fiber (Nylon 6.6 100 Denari)	WELLMAN INTERNATIONAL LTD
100 denier fiber (Nylon 6.6 100 Denari)	WELLMAN INTERNATIONAL LTD
Liquid melanine (Cellofix M/50)	LAMBERTI SpA
Policril A/D (salt of polyacrylic resin)	FAR SpA
Technical urea	BASLINI SpA
Butofan LN 240S	BASF
Nylon Scrim or Polyester terephtalate (PET) Scrim	TESSITURA QUADRELLI SpA
Main characteristics	6,3 x 6,3 yarns/m^2 weight 150g/m^2 tensile 438 N:cm thickness 0,46 mm

5. Effect of the ratio of each component of the water mix on the example product performance

5.1. At the prebond level : Several experiments have been performed to establish the effects of the dry ratio latex/resin in the prebond making step on the product performance. Experimental products are described as following :

Example 1 is a full latex NBR coated prebond
Example 2 is a prebond made with a dry ratio of 90 % of latex and 10 % of resin
Example 3 is a prebond made with a dry ratio of 70 % of latex and 30 % of resin
Example 4 is a prebond made with a dry ratio of 50 % of latex and 50 % of resin
Example 5 is a prebond made with a dry ratio of 30 % of latex and 70 % of resin.

In the tables of the following examples : "R-M" means "Raw materials", "Qty" means "Quantity" in terms of percentage of the concerned component, "Gr/SQM" means "gram per square meter", the total weight ("Wet Qty") and dry weight ("Dry Qty") of each coating are given.

Experimental products have been compared to the reference "urethane-solvent-based" product industrially made and used.

Performance tests of the products with different ratios latex/resin have been carried out as follows :

Flexibility have been studied with "hand" evaluation according to the method described herein above. Cut & wear have been studied with the method herein above described. Finish level and "smear resistance" have been studied with the method herein above described.

The results are reported in the charts of figures 1 to 3.

The articles of Examples 2 and 3 demonstrated good flexibility compared to the reference product of Control Example A.

The articles of Examples 4 and 5 were evaluated as rigid when compared with the reference article of Control Example A. Consequently, these products may be difficult to form into articles where flexibility is required such as, for example, in endless belts.

The articles of Examples 2 and 3 show "wear resistance" which are in the acceptable range of the performance requirements. All products show good cut. None of the products show "smearing". All products show acceptable finish level.

In conclusion, products made with prebond dry ratio latex/resin from 90/10 to 70/30 show better performance.

EXAMPLE 1

EXPERIMENTAL PRODUCT

DRY RATIOS : Prebond : 100 latex Size : 60/40 latex/resin

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
60 denier nylon fiber				300
Sub total				450
Prebond Roll Coat				
Perbunan N 2890 latex	95,0			
Carbosol CMC	4,0			
Dye - Marrone permasol MU	1,0			
Sub total	100,0	1000	41	410
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
Lacfen 420 phenolic resin	22,5			
Triethanolamine 85	2,0			
Butofan LN240S latex	55,0			
Dye - Marrone permasol MU	1,0			
water	19,4			
Sub total	100,0	177	45	79
Total		3528		2460

EXAMPLE 2

EXPERIMENTAL PRODUCT

DRY RATIOS : Prebond : 90/10 latex/resin Size : 60/40 latex/resin

DESIGNATION	RM Qty weight%	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
60 denier nylon fiber				300
Sub total				450
Prebond Roll Coat				
Lacfen 420 phenolic resin	6,7			
Triethanolamine 85	0,3			
Perbunan N 2890 latex	88,0			
Carbosol CMC	4,1			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	961	42	404
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
Lacfen 420 phenolic resin	22,5			
Triethanolamine 85	2,0			
Butofan LN240S latex	55,0			
Dye - Marrone permasol MU	1,0			
water	19,4			
Sub total	100,0	177	45	79
Total		3489		2454

EXAMPLE 3

EXPERIMENTAL PRODUCT
DRY RATIOS : Prebond : 70/30 latex/resin Size : 60/40 latex/resin

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
60 denier nylon fiber				300
Sub total				450
Prebond Roll Coat				
Lacfen 420 phenolic resin	20,7			
Triethanolamine 85	0,9			
Perbunan N 2890 latex	73,3			
Carbosol CMC	4,1			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	955	44	420
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
Lacfen 420 phenolic resin	22,5			
Triethanolamine 85	2,0			
Butofan LN240S latex	55,0			
Dye - Marrone permasol MU	1,0			
water	19,4			
Sub total	100,0	177	45	79
Total		3483		2470

EXAMPLE 4

EXPERIMENTAL PRODUCT

DRY RATIOS : Prebond : 50/50 latex/resin Size : 60/40 latex/resin

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
60 denier nylon fiber				300
Sub total				450
Prebond Roll Coat				
Lacfen 420 phenolic resin	37,0			
Triethanolamine 85	1,9			
Perbunan N 2890 latex	55,5			
Carbosol CMC	4,6			
Dye - Marrone permasol MU	1,1			
Sub total	100,0	854	49	418
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
Lacfen 420 phenolic resin	22,5			
Triethanolamine 85	2,0			
Butofan LN240S latex	55,0			
Dye - Marrone permasol MU	1,0			
water	19,4			
Sub total	100,0	177	45	79
Total		3382		2469

EXAMPLE 5

EXPERIMENTAL PRODUCT

DRY RATIOS : Prebond : 30/70 latex/resin Size : 60/40 latex/resin

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
60 denier nylon fiber				300
Sub total				450
Prebond Roll Coat				
Lacfen 420 phenolic resin	55,7			
Triethanolamine 85	2,7			
Perbunan N 2890 latex	35,5			
Carbosol CMC	4,9			
Dye - Marrone permasol MU	1,1			
Sub total	100,0	788	53	418
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
Lacfen 420 phenolic resin	22,5			
Triethanolamine 85	2,0			
Butofan LN240S latex	55,0			
Dye - Marrone permasol MU	1,0			
water	19,4			
Sub total	100,0	177	45	79
Total		3316		2468

5.2. Size spray - Study I:

Two sets of experiments have been performed to establish the effects of the latex/resin dry ratio in the size coating on product performance. The articles of the examples are described as follows.

Example 6 is a full latex NBR sprayed size

Example 7 is a size made with a dry ratio of 80 % of latex and 20 % of resin ;

Example 8 is a size made with a dry ratio of 60 % of latex and 40 % of resin ;

Example 9 is a size made with a dry ratio of 40 % of latex and 60 % of resin ;

Example 10 is a size made with a dry ratio of 20 % of latex and 80 % of resin;

Example 11 is a full phenolic resin sprayed size.

Formulations in details are described herein after.

Performance tests of the products with different ratios latex/resin have been carried out as follows :

Flexibility has been studied with "hand" evaluation. "Cut" and "wear" have been studied with the method previously described. Finish level and "smear resistance" have been studied with the method previously described.

The results are reported in the charts of figures 4 to 6.

The articles of Examples 8 and 9 demonstrate the best wear resistance. These products show the lowest roughness values to achieve the best finished results. The "cut" increases with the amount of phenolic resin in the size coating. Flexibility does not appear to be affected by the size ratio modifications. None of the products in the inventive Examples showed smearing. In conclusion, the products made with a dry size ratio of latex/resin from 60/40 to 40/60 demonstrated the best overall performance.

EXAMPLE 6

EXPERIMENTAL PRODUCT

DRY RATIOS : Prebond : 90/10 latex/resin Size : 100 latex

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
60 denier nylon fiber				300
Sub total				450
Prebond Roll Coat				
Lacfen 420 phenolic resin	6,7			
Triethanolamine 85	0,3			
Perbunan N 2890 latex	88,0			
Carbosol CMC	4,1			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	961	42	404
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
Butofan LN240S latex	100,0			
Sub total	100,0	170	41	70
Total		3482		2444

EXAMPLE 7

EXPERIMENTAL PRODUCT

DRY RATIOS : Prebond : 90/10 latex/resin Size : 80/20 latex/resin

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
60 denier nylon fiber				300
Sub total				450
Prebond Roll Coat				
Lacfen 420 phenolic resin	6,7			
Triethanolamine 85	0,3			
Perbunan N 2890 latex	88,0			
Carbosol CMC	4,1			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	961	42	404
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
Lacfen 420 phenolic resin	13,5			
Triethanolamine 85	1,2			
Butofan LN240S latex	85,3			
Sub total	100,0	163	43	70
Total		3475		2445

EXAMPLE 8

EXPERIMENTAL PRODUCT

DRY RATIOS : Prebond : 90/10 latex/resin Size : 60/40 latex/resin

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
60 denier nylon fiber				300
Sub total				450
Prebond Roll Coat				
Lacfen 420 phenolic resin	6,7			
Triethanolamine 85	0,3			
Perbunan N 2890 latex	88,0			
Carbosol CMC	4,1			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	961	42	404
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
Lacfen 420 phenolic resin	29,0			
Triethanolamine 85	3,2			
Butofan LN240S latex	67,7			
Sub total	100,0	155	45	70
Total		3467		2444

EXAMPLE 9

EXPERIMENTAL PRODUCT

DRY RATIOS : Prebond : 90/10 latex/resin Size :40/60 latex/resin

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
60 denier nylon fiber				300
Sub total				**450**
Prebond Roll Coat				
Lacfen 420 phenolic resin	6,7			
Triethanolamine 85	0,3			
Perbunan N 2890 latex	88,0			
Carbosol CMC	4,1			
Dye - Marrone permasol MU	0,9			
Sub total	**100,0**	**961**	**42**	**404**
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	**100,0**	**1901**	**80**	**1521**
Size Spray				
Lacfen 420 phenolic resin	47,9			
Triethanolamine 85	4,1			
Butofan LN240S latex	47,9			
Sub total	**100,0**	**146**	**48**	**70**
Total		**3458**		**2445**

EXAMPLE 10

EXPERIMENTAL PRODUCT

DRY RATIOS : Prebond : 90/10 latex/resin Size :20/80 latex/resin

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
60 denier nylon fiber				300
Sub total				**450**
Prebond Roll Coat				
Lacfen 420 phenolic resin	6,7			
Triethanolamine 85	0,3			
Perbunan N 2890 latex	88,0			
Carbosol CMC	4,1			
Dye - Marrone permasol MU	0,9			
Sub total	**100,0**	**961**	**42**	**404**
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	**100,0**	**1901**	**80**	**1521**
Size Spray				
Lacfen 420 phenolic resin	68,9			
Triethanolamine 85	5,2			
Butofan LN240S latex	25,9			
Sub total	**100,0**	**135**	**52**	**70**
Total		**3447**		**2445**

EXAMPLE 11

EXPERIMENTAL PRODUCT
DRY RATIOS : Prebond : 90/10 latex/resin Size :100 resin

DESIGNATION	RM Qty weight%	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
60 denier nylon fiber				300
Sub total				450
Prebond Roll Coat				
Lacfen 420 phenolic resin	6,7			
Triethanolamine 85	0,3			
Perbunan N 2890 latex	88,0			
Carbosol CMC	4,1			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	961	42	404
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
Lacfen 420 phenolic resin	100,0			
Sub total	100,0	113	62	70
Total		3425		2444

5.3. "size" spray-study II : Additional articles are described wherein the dry ratio of the latex/resinis varied for the size coating. All of the articles in the following set of examples have a prebond latex/resin ration of 70/30.

Example 12 is a full latex NBR sprayed size.
Example 13 is a size made with a dry ratio of 60 % of latex and 40 % of resin.
Example 14 is a size made with a dry ratio of 30 % of latex and 70 % of resin.

Performance testing of the articles of the above Examples gave results consistent with those given above for Study I.

EXAMPLE 12

EXPERIMENTAL PRODUCT
DRY RATIOS : Prebond : 70/30 latex/resin Size :100 latex

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
60 denier nylon fiber				300
Sub total				450
Prebond Roll Coat				
Lacfen 420 phenolic resin	20,7			
Triethanolamine 85	0,9			
Perbunan N 2890 latex	73,3			
Carbosol CMC	4,1			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	955	44	420
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
Butofan LN240S latex	98,8			
Dye - Marrone permasol MU	1,2			
Sub total	100,0	170	41	70
Total		3476		2461

EXAMPLE 13

EXPERIMENTAL PRODUCT

DRY RATIOS : Prebond : 70/30 latex/resin Size :60/40 latex/resin

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
60 denier nylon fiber				300
Sub total				450
Prebond Roll Coat				
Lacfen 420 phenolic resin	20,7			
Triethanolamine 85	0,9			
Perbunan N 2890 latex	73,3			
Carbosol CMC	4,1			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	955	44	420
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
Lacfen 420 phenolic resin	28,0			
Triethanolamine 85	2,8			
Butofan LN240S latex	67,8			
Dye - Marrone permasol MU	1,4			
Sub total	100,0	143	45	64
Total		3449		2455

EXAMPLE 14

EXPERIMENTAL PRODUCT
DRY RATIOS : Prebond : 70/30 latex/resin Size :30/70 latex/resin

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
60 denier nylon fiber				300
Sub total				450
Prebond Roll Coat				
Lacfen 420 phenolic resin	20,7			
Triethanolamine 85	0,9			
Perbunan N 2890 latex	73,3			
Carbosol CMC	4,1			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	955	44	420
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
Lacfen 420 phenolic resin	59,0			
Triethanolamine 85	2,8			
Butofan LN240S latex	36,8			
Dye - Marrone permasol MU	1,4			
Sub total	100,0	144	52	75
Total		3450		2466

5.4. Another set of examples have been made with various fiber web compositions.
Formulation details are described hereinafter. The performance tests show the results presented in tables 1 to 4 of Figures 7 to 8.

EXAMPLE 15

EXPERIMENTAL PRODUCT
DRY RATIO : Prebond : 90/10 latex/resin

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
60 denier nylon fiber				300
Sub total				450
Prebond Roll Coat				
water	11,4			
Lacfen 420 phenolic resin	5,6			
Policril A/D thickener	3,0			
Triethanolamine 85	1,5			
Perbunan N 2890 latex	73,0			
Technical urea	2,5			
Cellofix M50 liquid melamine	1,5			
Dye - Marrone permasol MU	1,5			
Sub total	100,0	654,65	65	426
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
water	18,6			
Lacfen 420 phenolic resin	21,7			
Perbunan N2890 latex	52,9			
Melamine in powder	3,9			
Triethanolamine 85	1,0			
Dye - Marrone permasol MU	2,0			
Sub total	100,0	183,8	42	77
Total		3189		2474

EXAMPLE 16

EXPERIMENTAL PRODUCT
DRY RATIO : Prebond : 90/10 latex/resin

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
100 denier nylon fiber				300
Sub total				450
Prebond Roll Coat				
water	11,4			
Lacfen 420 phenolic resin	5,6			
Policril A/D thickener	3,0			
Triethanolamine 85	1,5			
Perbunan N 2890 latex	73,0			
Technical urea	2,5			
Cellofix M50 liquid melamine	1,5			
Dye - Marrone permasol MU	1,5			
Sub total	100,0	654,65	65	426
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
water	18,6			
Lacfen 420 phenolic resin	21,7			
Perbunan N2890 latex	52,9			
Melamine in powder	3,9			
Triethanolamine 85	1,0			
Dye - Marrone permasol MU	2,0			
Sub total	100,0	183,8	42	77
Total		3189		2474

EXAMPLE 17

EXPERIMENTAL PRODUCT
DRY RATIO : Prebond : 90/10 latex/resin

DESIGNATION	RM Qty weight%	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Polyester (PET) scrim				250
100 denier nylon fiber				300
Sub total				550
Prebond Roll Coat				
water	11,4			
Lacfen 420 phenolic resin	5,6			
Policril A/D thickener	3,0			
Triethanolamine 85	1,5			
Perbunan N 2890 latex	73,0			
Technical urea	2,5			
Cellofix M50 liquid melamine	1,5			
Dye - Marrone permasol MU	1,5			
Sub total	100,0	654,65	65	426
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
water	18,6			
Lacfen 420 phenolic resin	21,7			
Perbunan N2890 latex	52,9			
Melamine in powder	3,9			
Triethanolamine 85	1,0			
Dye - Marrone permasol MU	2,0			
Sub total	100,0	183,8	42	77
Total		3289		2574

EXAMPLE 18

EXPERIMENTAL PRODUCT
DRY RATIO : Prebond : 90/10 latex/resin

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Polyester (PET) scrim				250
60 denier nylon fiber				300
Sub total				550
Prebond Roll Coat				
water	11,4			
Lacfen 420 phenolic resin	5,6			
Policril A/D thickener	3,0			
Triethanolamine 85	1,5			
Perbunan N 2890 latex	73,0			
Technical urea	2,5			
Cellofix M50 liquid melamine	1,5			
Dye - Marrone permasol MU	1,5			
Sub total	100,0	654,65	65	426
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
water	18,6			
Lacfen 420 phenolic resin	21,7			
Perbunan N2890 latex	52,9			
Melamine in powder	3,9			
Triethanolamine 85	1,0			
Dye - Marrone permasol MU	2,0			
Sub total	100,0	183,8	42	77
Total		3289		2574

EXAMPLE 19

EXPERIMENTAL PRODUCT
DRY RATIO : Prebond : 70/30 latex/resin

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Polyester (PET) scrim				250
100 denier nylon fiber				300
Sub total				550
Prebond Roll Coat				
water	11,4			
Lacfen 420 phenolic resin	17,5			
Policril A/D thickener	3,0			
Triethanolamine 85	1,5			
Perbunan N 2890 latex	61,1			
Technical urea	2,5			
Cellofix M50 liquid melamine	1,5			
Dye - Marrone permasol MU	1,5			
Sub total	100,0	654,6	67	439
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
water	18,6			
Lacfen 420 phenolic resin	21,7			
Perbunan N2890 latex	52,9			
Melamine in powder	3,9			
Triethanolamine 85	1,0			
Dye - Marrone permasol MU	2,0			
Sub total	100,0	183,8	42	77
Total		3289		2587

EXAMPLE 20

EXPERIMENTAL PRODUCT
DRY RATIO : Prebond : 70/30 latex/resin

DESIGNATION	RM Qty weight%	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				250
60 denier nylon fiber				300
Sub total				550
Prebond Roll Coat				
water	11,4			
Lacfen 420 phenolic resin	17,5			
Policril A/D thickener	3,0			
Triethanolamine 85	1,5			
Perbunan N 2890 latex	61,1			
Technical urea	2,5			
Cellofix M50 liquid melamine	1,5			
Dye - Marrone permasol MU	1,5			
Sub total	100,0	654,6	67	439
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
water	18,6			
Lacfen 420 phenolic resin	21,7			
Perbunan N2890 latex	52,9			
Melamine in powder	3,9			
Triethanolamine 85	1,0			
Dye - Marrone permasol MU	2,0			
Sub total	100,0	183,8	42	77
Total		3289		2587

EXAMPLE 21

EXPERIMENTAL PRODUCT
DRY RATIO : Prebond : 70/30 latex/resin

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
70 denier nylon fiber				200
58 denier nylon fiber				86
Sub total				436
Prebond Roll Coat				
water	11,4			
Lacfen 420 phenolic resin	17,5			
Policril A/D thickener	3,0			
Triethanolamine 85	1,5			
Perbunan N 2890 latex	61,1			
Technical urea	2,5			
Cellofix M50 liquid melamine	1,5			
Dye - Marrone permasol MU	1,5			
Sub total	100,0	654,6	67	439
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
water	18,6			
Lacfen 420 phenolic resin	21,7			
Perbunan N2890 latex	52,9			
Melamine in powder	3,9			
Triethanolamine 85	1,0			
Dye - Marrone permasol MU	2,0			
Sub total	100,0	183,8	42	77
Total		3175		2473

EXAMPLE 22

EXPERIMENTAL PRODUCT
DRY RATIO : Prebond : urethane resin - reference

DESIGNATION	RM Qty weight%	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
70 denier nylon fiber				200
58 denier nylon fiber				86
Sub total				436
Prebond Roll Coat				
BL 16 urethane resin	62,3			
MDA in PM Acetate solution	19,2			
PM Acetate	13,7			
Lithium stearate premix	3,6			
Brown pigment	1,2			
Sub total	100,0	642	65	417
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
80 grit Al2O3	33,6			
100 grit Al2O3	16,8			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
water	18,6			
Lacfen 420 phenolic resin	21,7			
Perbunan N2890 latex	52,9			
Melamine in powder	3,9			
Triethanolamine 85	1,0			
Dye - Marrone permasol MU	2,0			
Sub total	100,0	183,8	42	77
Total		3163		2451

EXAMPLE 23

EXPERIMENTAL PRODUCT
DRY RATIO : Prebond : 70/30 latex/resin

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Polyester (PET) scrim				250
100 denier nylon fiber				300
Sub total				550
Prebond Roll Coat				
water	11,4			
Lacfen 420 phenolic resin	17,5			
Policril A/D thickener	3,0			
Triethanolamine 85	1,5			
Perbunan N 2890 latex	61,1			
Technical urea	2,5			
Cellofix M50 liquid melamine	1,5			
Dye - Marrone permasol MU	1,5			
Sub total	100,0	654,6	67	439
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
100 grit Al2O3	50,4			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
water	18,6			
Lacfen 420 phenolic resin	21,7			
Perbunan N2890 latex	52,9			
Melamine in powder	3,9			
Triethanolamine 85	1,0			
Dye - Marrone permasol MU	2,0			
Sub total	100,0	183,8	42	77
Total		3289		2587

EXAMPLE 24

EXPERIMENTAL PRODUCT
DRY RATIO : Prebond : 70/30 latex/resin

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
70 denier nylon fiber				200
58 denier nylon fiber				86
Sub total				436
Prebond Roll Coat				
water	11,4			
Lacfen 420 phenolic resin	17,5			
Policril A/D thickener	3,0			
Triethanolamine 85	1,5			
Perbunan N 2890 latex	61,1			
Technical urea	2,5			
Cellofix M50 liquid melamine	1,5			
Dye - Marrone permasol MU	1,5			
Sub total	100,0	654,6	67	439
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
100 grit Al2O3	50,4			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
water	18,6			
Lacfen 420 phenolic resin	21,7			
Perbunan N2890 latex	52,9			
Melamine in powder	3,9			
Triethanolamine 85	1,0			
Dye - Marrone permasol MU	2,0			
Sub total	100,0	183,8	42	77
Total		3175		2473

EXAMPLE 25

EXPERIMENTAL PRODUCT
DRY RATIO : Prebond : urethane resin - reference

DESIGNATION	RM Qty weight %	Wet Qty Gr/SQM	% solids	Dry qty Gr/SQM
Fiber web				
Nylon scrim				150
70 denier nylon fiber				200
58 denier nylon fiber				86
Sub total				436
Prebond Roll Coat				
BL 16 urethane resin	62,3			
MDA in PM Acetate solution	19,2			
PM Acetate	13,7			
Lithium stearate premix	3,6			
Brown pigment	1,2			
Sub total	100,0	642	65	417
Slurry Spray				
water	7,0			
Carbosol CMC	2,0			
100 grit Al2O3	50,4			
Lacfen 415 phenolic resin	20,2			
Policril 307R acrylic resin	10,9			
Melamine in powder	1,2			
Calcium carbonate	7,4			
Dye - Marrone permasol MU	0,9			
Sub total	100,0	1901	80	1521
Size Spray				
water	18,6			
Lacfen 420 phenolic resin	21,7			
Perbunan N2890 latex	52,9			
Melamine in powder	3,9			
Triethanolamine 85	1,0			
Dye - Marrone permasol MU	2,0			
Sub total	100,0	183,8	42	77
Total		3163		2451

Claims

1. Surface conditioning article comprising an organic matrix and water-based organic binders adhered to said matrix, said binders including a first binder and a second binder with abrasive particles dispersed and adhered within said second binder, wherein the first binder comprises a mixture of a phenolic resin and a carboxylated butadiene-acrylonitrile copolymer latex, in the range of weight ratio of dry materials of said latex versus said phenolic resin of 90/10 to 60/40.

2. A surface conditioning article according to claim 1, wherein the said phenolic resin of the first binder is a resole-type phenolic resin with a water tolerance of at least 500 % by weight.

3. A surface conditioning article according to claim 1 or 2, wherein said phenolic resin of the first binder has a molecular weight in the range of 100 to 1000.

4. A surface conditioning article according to anyone of claims 1 to 3, wherein the said carboxylated butadiene-acrylonitrile latex has a molar percent of acrylonitrile from 25 %. to 35 %.

5. A surface conditioning article according to anyone of claims 1 to 4, wherein the latex particles have a size in the range of 10 to 500 nm.

6. A surface conditioning article according to anyone of claims 1 to 5, comprising a third binder coated over the second binder, said third binder comprising a mixture of phenolic resin and carboxylated butadiene acrylonitrile copolymer latex.

7. A surface conditioning article according to claim 6, wherein the weight ratio of dry materials of said latex versus said phenolic resin in the third binder is in the range of 60/40 to 40/60.

8. A surface conditioning article according to claim 6 or 7, wherein the phenolic resin and carboxylated butadiene-acrylonitrile latex are the same in the first and third binders.

9. A surface conditioning article according to anyone of claims 1 to 8, wherein the phenolic resin is selected from the group consisting of Lacfen 420® from Satef Huttens Albertus Spa and SW 378® from Bakelite.

10. A surface conditioning article according to anyone of claims 1 to 9, wherein the carboxylated butadiene-acrylonitrile latex is selected from the group consisting of Perbunan®, N2890 from Bayer and LN 240S® from BASF.

11. A surface conditioning article according to anyone of claims 1 to 10, wherein the latex versus phenolic resin weight ratio is of 70/30 in the first binder and 60/40 in the third binder.

12. A surface conditioning article according to anyone of claims 1 to 11, wherein said organic matrix comprises an open, lofty, three-dimensional nonwoven web.

13. A surface conditioning article according to claim 12, wherein the said nonwoven web comprises organic polyester or polyamid fibers.

14. A surface conditioning article according to claim 13, wherein the fibers have dimensions between 10 to 100 denier and between 10 to 100 mm for the length.

15. A surface conditioning article according to claim 13 wherein the organix matrix is affixed to a reinforcing scrim.

16. A method for making a layered composite from which a surface conditioning article according to anyone of claims 1 to 15 may be machined, the method comprising :

    a) coating a major portion of the organic fibers of an open, lofty, three-dimensional nonwoven web with the first binder composition to form a first coated web ;
    b) exposing the first coated web to energy sufficient to at least partially cure the first binder composition to form an open, lofty, three-dimensional nonwoven prebonded web of fibers ;
    c) coating at least a portion of the fibers of the prebonded web with an aqueous slurry comprising water, abrasive particles and a said second binder to form a second coated web ;

d) exposing the second coated web to energy sufficient to cure the second binder ;

e) coating at least a portion of the fibers of the second coated web with a third binder ;

f) exposing the third coated web to energy sufficient to cure the third binder, remove substantially all the water, thereby forming a substantially dried web ;

g) juxtaposing a plurality of substantially dried webs of step f) to form a precursor layered composite ; and

h) compressing the precursor layered composite with pressure and at a temperature sufficient to form the layered composite.

17. A method according to claim 16, wherein before step a), the following steps are performed, comprising :

1) forming an open, lofty, three-dimensional nonwoven web of organic fibers ; and

2) entangling the organic fibers of the nonwoven web to form an entangled web.

18. A method according to claim 16 or 17, wherein in steps c) and e) the said second and third binders are sprayed.

19. A method according to anyone of claims 16 to 18, wherein said layered composite is machined into a surface conditioning article in the form of discs, wheels, rectangular blocks, endless belts.

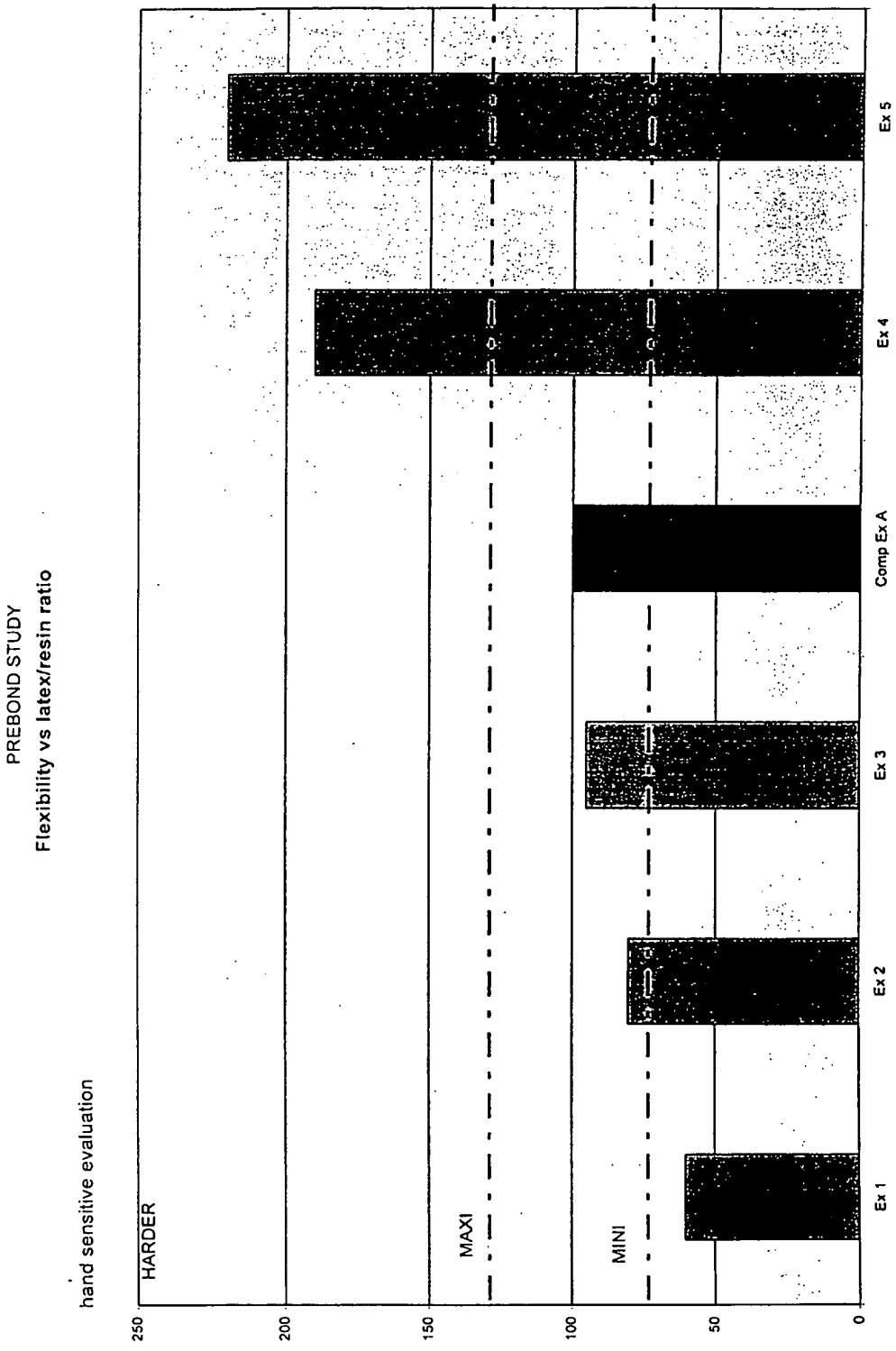
PREBOND STUDY
Flexibility vs latex/resin ratio
hand sensitive evaluation
HARDER
MAXI
MINI
250
200
150
100
50
0
Ex 1
Ex 2
Ex 3
Comp Ex A
Ex 4
Ex 5

FIGURE 1

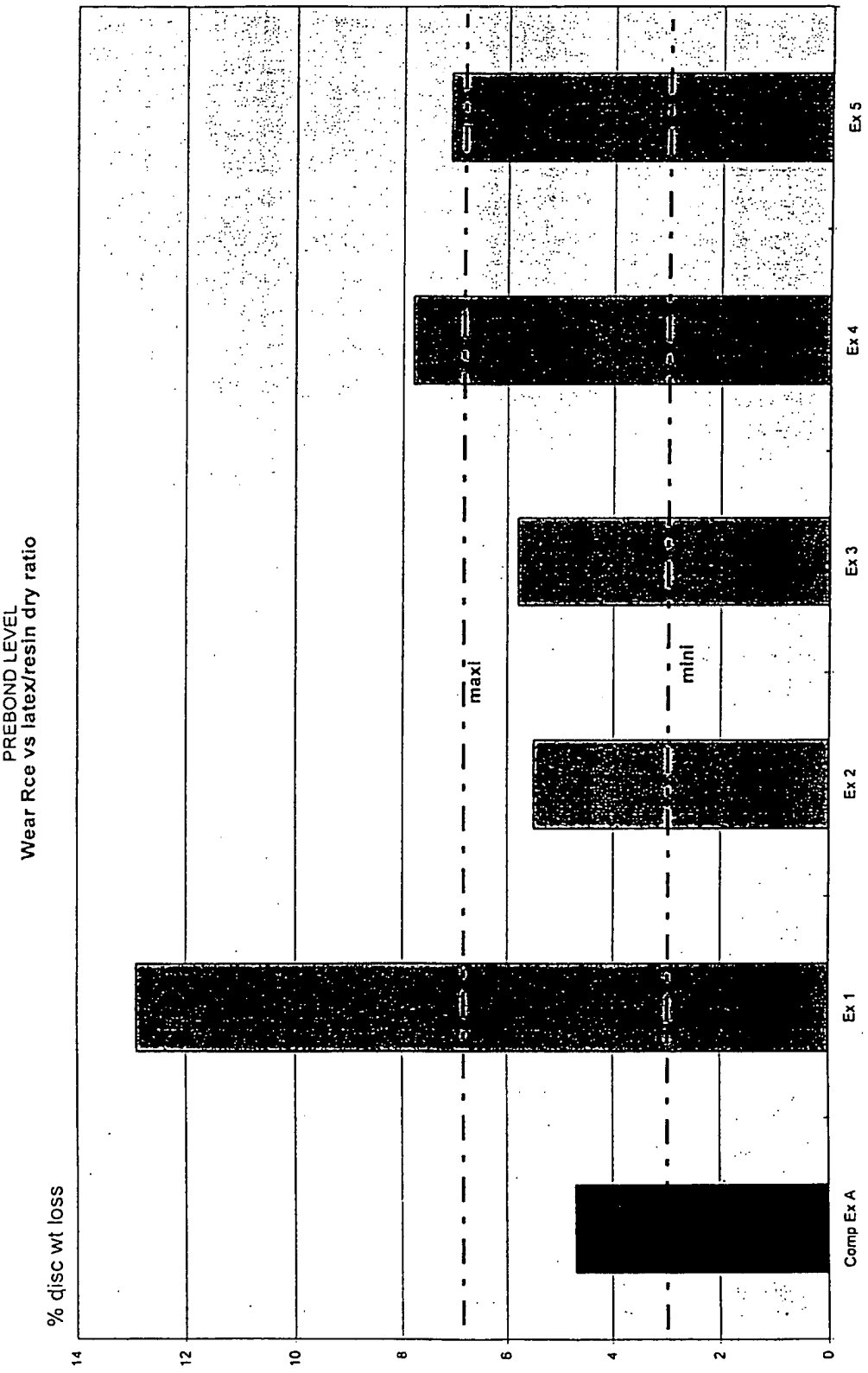
PREBOND LEVEL
Wear Rce vs latex/resin dry ratio
% disc wt loss
14
12
10
8
6
4
2
0
maxi
mini
Ex 5
Ex 4
Ex 3
Ex 2
Ex 1
Comp Ex A

FIGURE 2

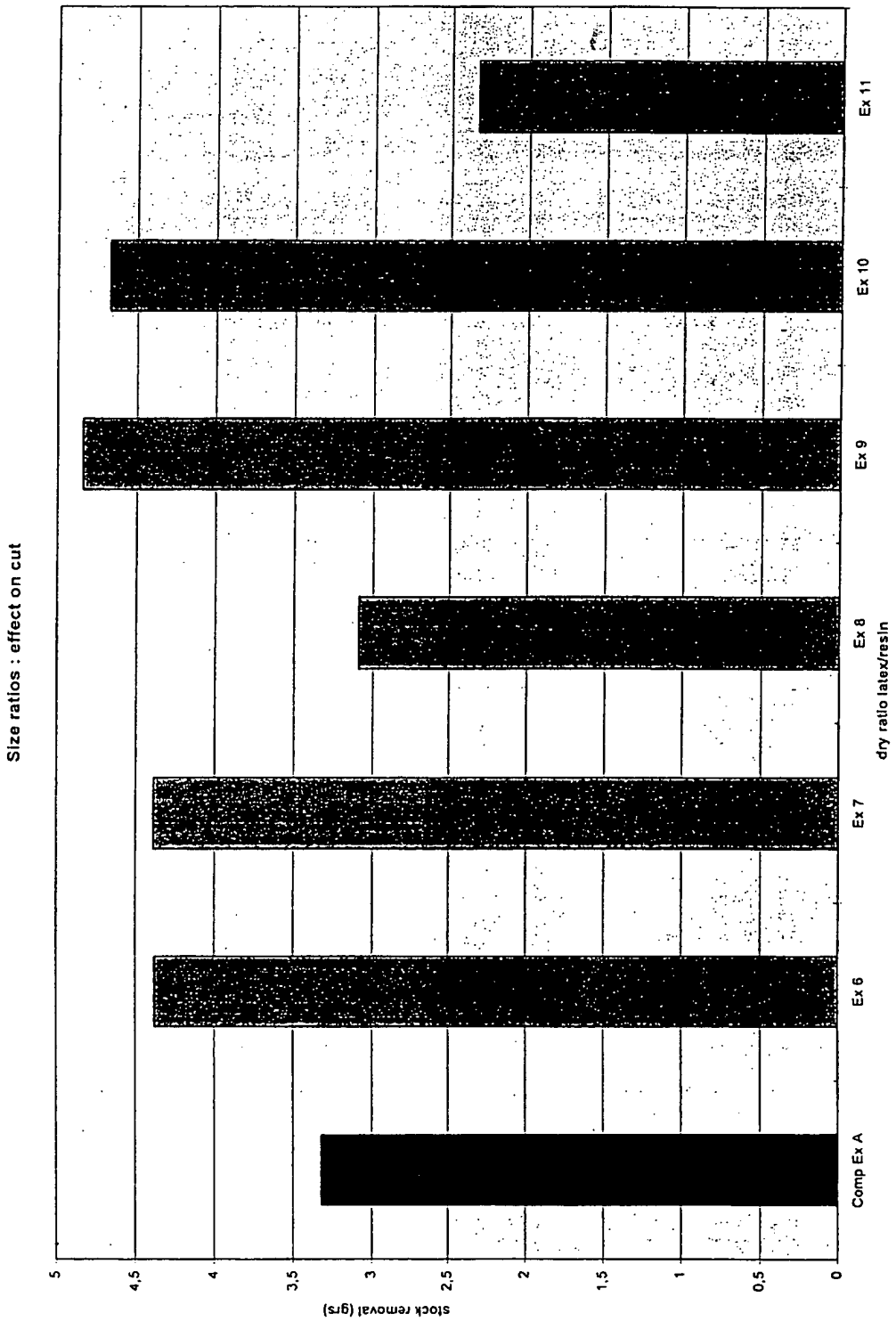
Size ratios : effect on cut
stock removal (grs)
5
4,5
4
3,5
3
2,5
2
1,5
1
0,5
0
Comp Ex A
Ex 6
Ex 7
Ex 8
Ex 9
Ex 10
Ex 11
dry ratio latex/resin

FIGURE 3

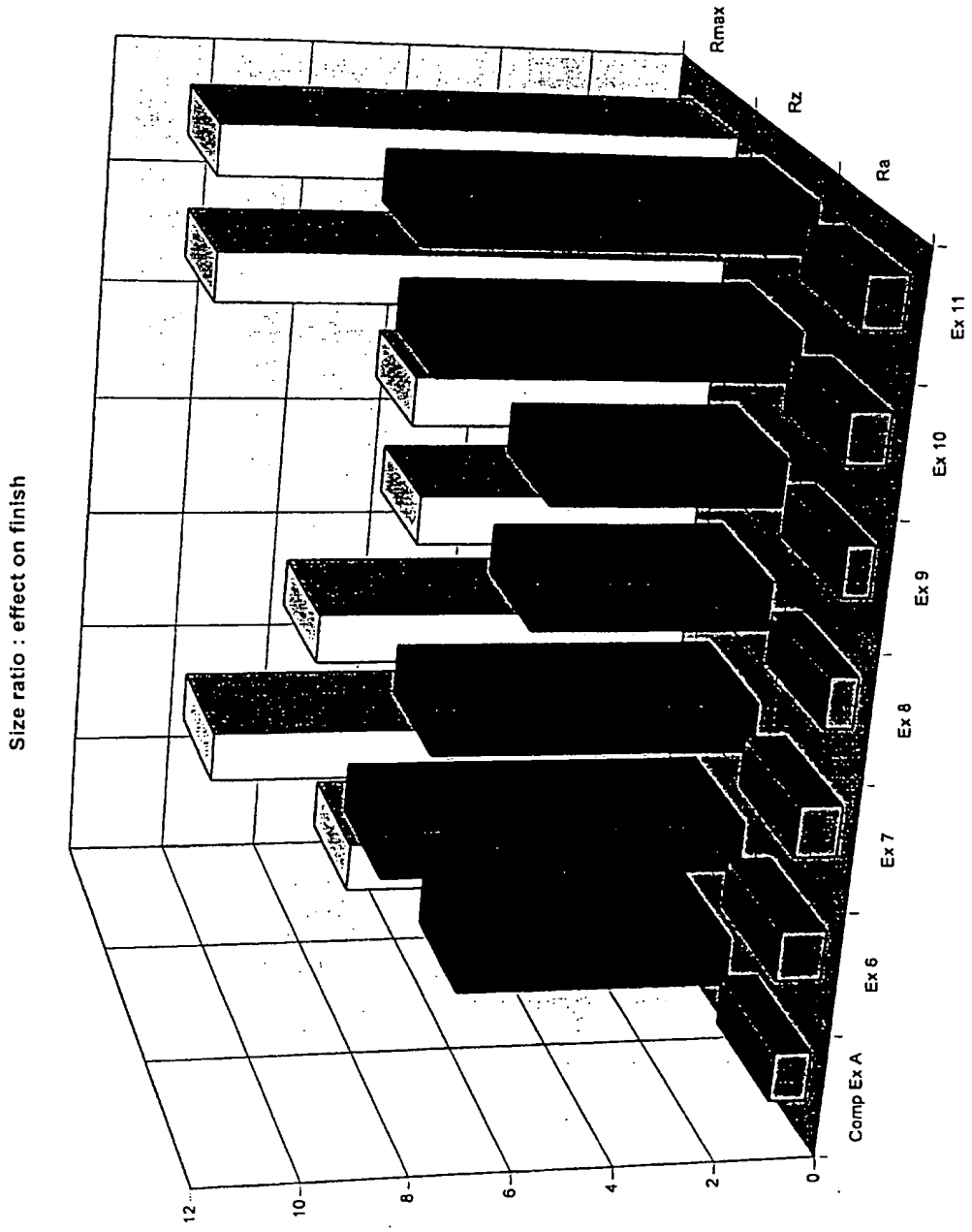
Size ratio : effect on finish
Rmax
Rz
Ra
Ex 11
Ex 10
Ex 9
Ex 8
Ex 7
Ex 6
Comp Ex A
0
2
4
6
8
10
12

FIGURE 4

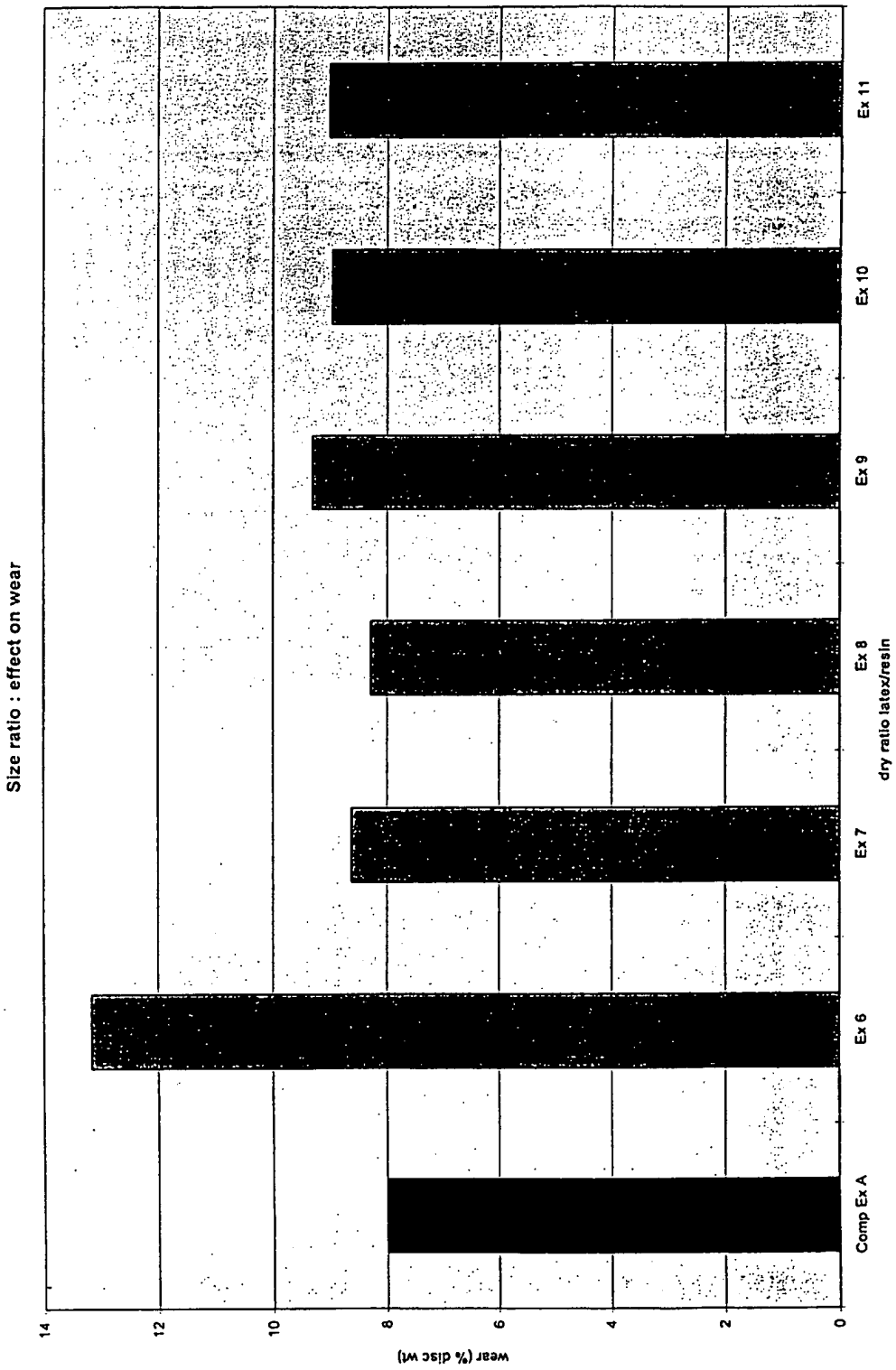
Size ratio : effect on wear
Comp Ex A
Ex 6
Ex 7
Ex 8
Ex 9
Ex 10
Ex 11
dry ratio latex/resin
0
2
4
6
8
10
12
14
wear (% disc wt)

FIGURE 5

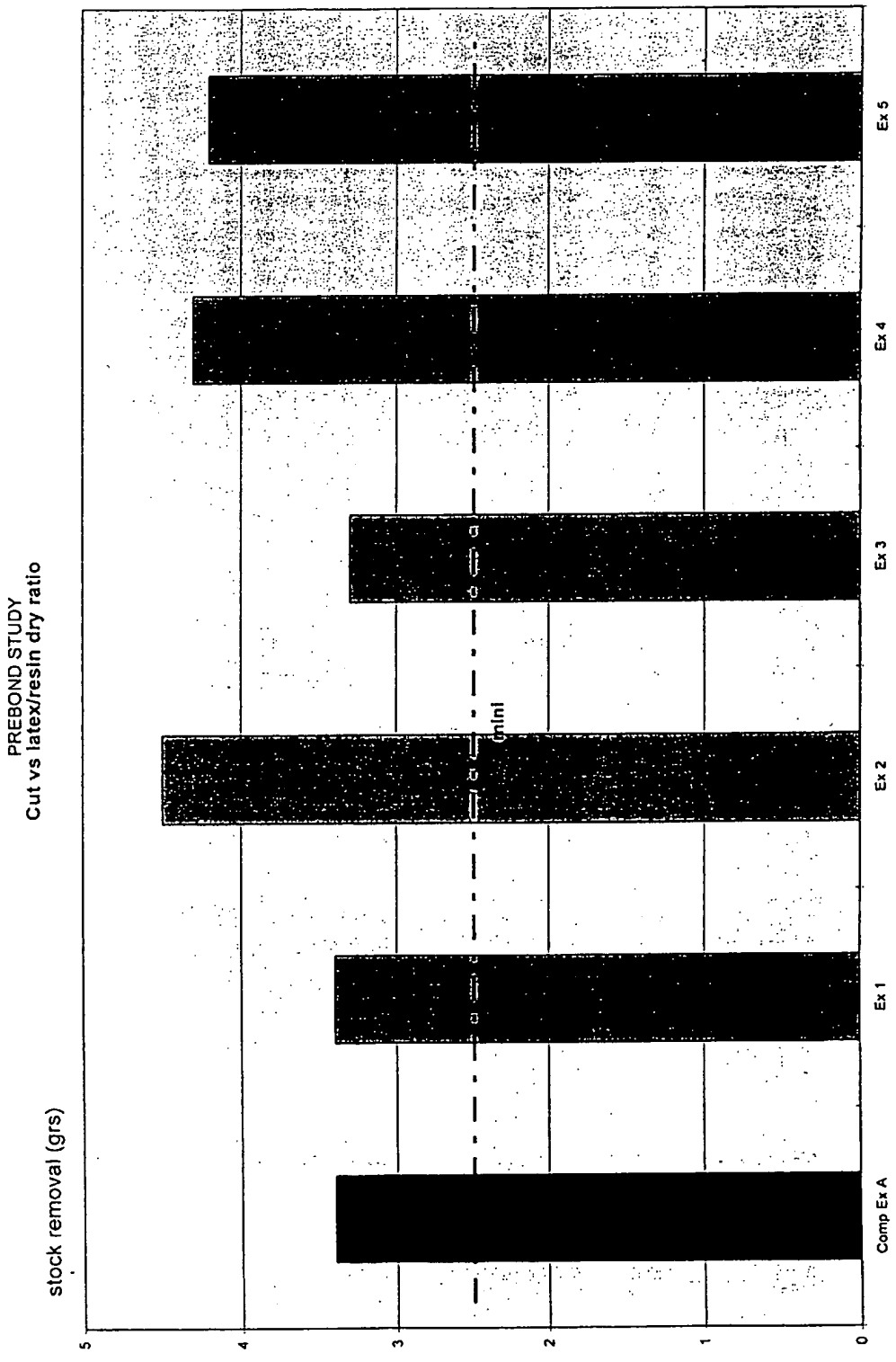
PREBOND STUDY
Cut vs latex/resin dry ratio
stock removal (grs)
5
4
3
2
1
0
(min)
Ex 5
Ex 4
Ex 3
Ex 2
Ex 1
Comp Ex A

FIGURE 6

TABLE 1

Performance test : Smearing resistance

IDENTIFICATION	SMEARING EVALUATION
Comparative Example A	No smearing
Example 15	No smearing
Example 16	No smearing
Example 17	No smearing
Example 18	No smearing
Example 19	No smearing
Example 20	No smearing
Example 21	No smearing
Example 22	No smearing
Example 23	No smearing
Example 24	No smearing
Example 25	No smearing

TABLE 2

Performance test : Hand tool evaluation in disc form

Product identification	Edge resistance evaluation	Paint removal time	loading resistance evaluation
Comparative	****	47 sec	**
Example A	****	40 sec	**
Example 20	****	41 sec	**
Example 21	****	46 sec	**
Example 22	****	34 sec	**
Example 23	****	41 sec	**
Example 24	****	40 sec	**
Example 25	****	39 sec	**

evaluation scale : one star : bad behaviour to five stars : excellent behaviour

FIGURE 7

TABLE 3

Performance test : Cut & Wear in belt and disc forms

Products	Belt tester			Disc tester		
	Cut	Wear	Efficiency	Cut	Wear	Efficiency
comparative Ex A	239,9	41,6	5,8	3,88	5,23	0,74
	243,7	46,8	5,2			
Example 15	229,9	38,9	5,9	3,73	4,43	0,84
	229,6	38,5	6,0			
Example 16	229,9	36,2	6,4	3,68	3,68	1,00
	232,5	36,5	6,4			
Example 17	198,2	26,1	7,6	3,85	3,45	1,12
	196,7	24,7	8,0			
Example 18	221	41,5	5,3	3,63	3,93	0,92
	218,9	38,4	5,7			
Example 19	247,6	34,2	7,2	4,43	4,18	1,06
	243,7	33,6	7,3			

TABLE 4

Performance test : Finish level on stainless steel

Products	Rougness values (µm)		
	Ra	Rz	Rmax
Comparative Ex A	0,40	4,19	5,00
Example 15	0,42	4,07	4,91
Example 16	0,42	4,16	5,48
Example 17	0,46	4,31	5,54
Example 18	0,51	4,61	4,91
Example 19	0,61	5,42	6,63

FIGURE 8

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 40 2676

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	DATABASE WPI Section Ch, Week 8532 Derwent Publications Ltd., London, GB; Class AFP, AN 85-195279 (32) XP002003996 & SU-A-1 134 579 (UKR. ABRASSIVE GRIND.) , 15 January 1985	1,2,6-8, 11	B24D3/28 B24D11/00 B24D18/00
A	* abstract *	16,18,19	

X	DATABASE WPI Section Ch, Week 9014 Derwent Publications Ltd., London, GB; Class ALP, AN 90-106122 (14) XP002003997 & SU-A-1 509 239 (TIRASPOL. MOLDAVIZOL.) , 23 September 1989	1,2,4, 11-14	
A	* abstract *	19	

A	FR-A-2 346 106 (NORTON COMPANY) * the whole document *	1,6-8, 11,16, 18,19	TECHNICAL FIELDS SEARCHED (Int.Cl.6) B24D

A	DATABASE WPI Section Ch, Week 7709 Derwent Publications Ltd., London, GB; Class AF, AN 77-15139Y (09) XP002003998 & JP-A-52 005 373 (JAPAN VILENE K.K.) , 17 January 1977 * abstract *	1,12-15, 17,19	A47L B24B C09K C08L D06B D04H

A	EP-A-0 139 309 (RÜTGERSWERKE AKTIENGESELLSCHAFT) * the whole document * * specially page 8, lines 10-12 *	1,2,19	

	-/--		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28 May 1996	Molto Pinol, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EUROPEAN SEARCH REPORT

Application Number
EP 95 40 2676

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	DE-A-41 38 717 (AXEL KLAUKE) * the whole document * ---	1,2,19	
A	PROFESSOR DR. GERHARD W. BECKER, PROFESSOR DR. DIETRICH BRAUN; (COORDINATOR FOR VOL. 10) PROFESSOR DR. WILBRAND WOEBCKEN: "KUNSTSTOFF HANDBUCH - VOLUME 10 - DUROPLASTE" 1988 , CARL HANSER VERLAG , MÜNCHEN, DE XP002003995 * subchapter 9.5 "Textilvliesstoffe" - Dr. D. Eisele, pages 763-764 * * ch. 11, subch. 11.2 "Schleifsch." -Drs. Colleselli and Schwieger, pages 894,896,897,901-905 * * ch. 11, subch. 11.4 "Bindemittel" -Drs. Adolphs and Dietrich, pages 911-921 * ---	1-8, 12-15,19	
D,A	PROCEEDINGS OF THE AMERICAN CHEMICAL SOCIETY, DIVISION OF POLYMERIC MATERIALS : SCIENCE AND ENGINEERING . SPRING MEETING 1991, vol. 64, 1991, ATLANTA, GEORGIA, USA, pages 275-276, XP000561766 JOHN D. FISHER (SCHNECTADY CHEMICALS INC.): "WATER COMPATIBLE PHENOLIC RESINS" * the whole document * -----	2,3	TECHNICAL FIELDS SEARCHED (Int.Cl.6)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28 May 1996	Molto Pinol, F

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